
# Micro-Combined Heat & Power Generation

part 01

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# TOTEM ENERGY
## A SUBSIDIARY OF ASJA GROUP

With a strong expertise in centralized energy generation Asja Group decided years ago to move into the business of decentralized energy generation with a strong awareness it will play an essential role in the years ahead.

Through the daugther company TOTEM ENERGY, Asja Group has become a specialist in Onsite Energy Generation products and particularly in Micro Combined Heat and Power generation.

Its flagship product is the TOTEM micro CHP.

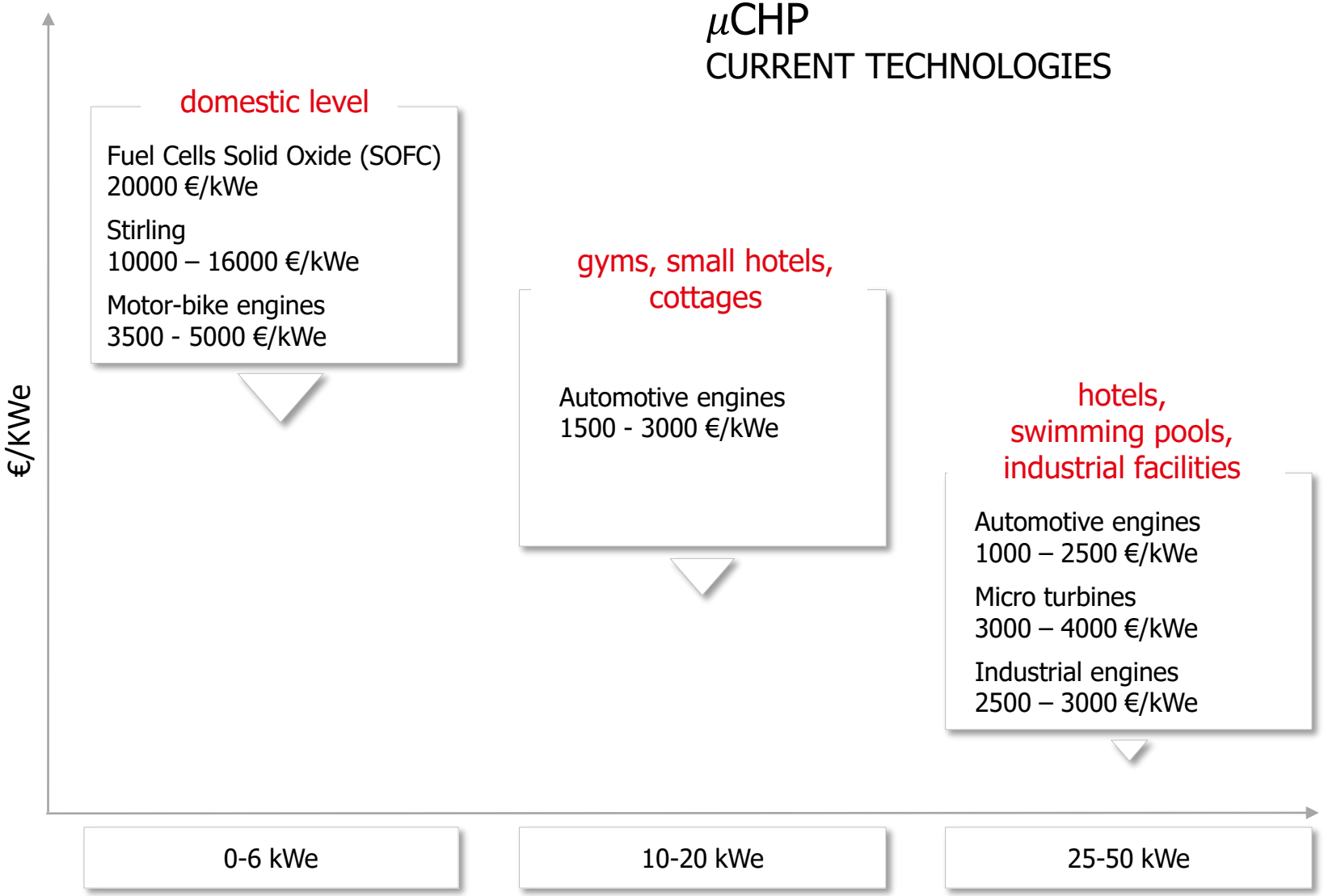
“

Our energy environment is changing rapidly as Governments globally strive to make cost-efficient use of resources while enabling the emergence of a low carbon economy. Innovative policy is crucial to enabling the emergence of those technologies that will deliver this outcome.

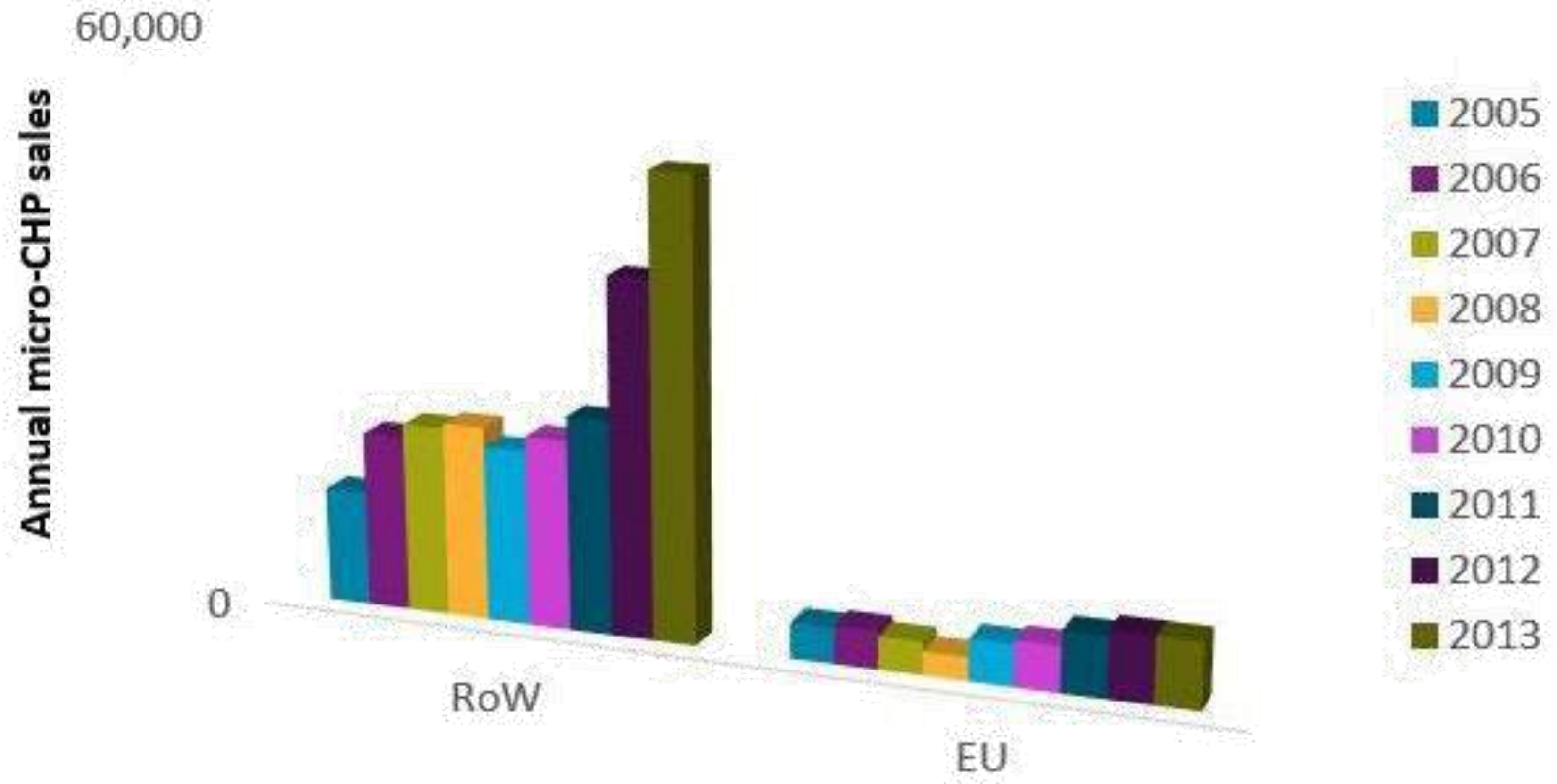
Micro Combined Heat and Power ($\mu$CHP), a cost-effective and flexible low carbon solution that generates heat and electricity on-site, can support the transformation of the energy system and the achievement of relevant policy objectives, including environmental ones. Widespread $\mu$CHP deployment can transfer a significant part of electricity generation at local level, creating significant benefits for the energy system and for consumers.

”

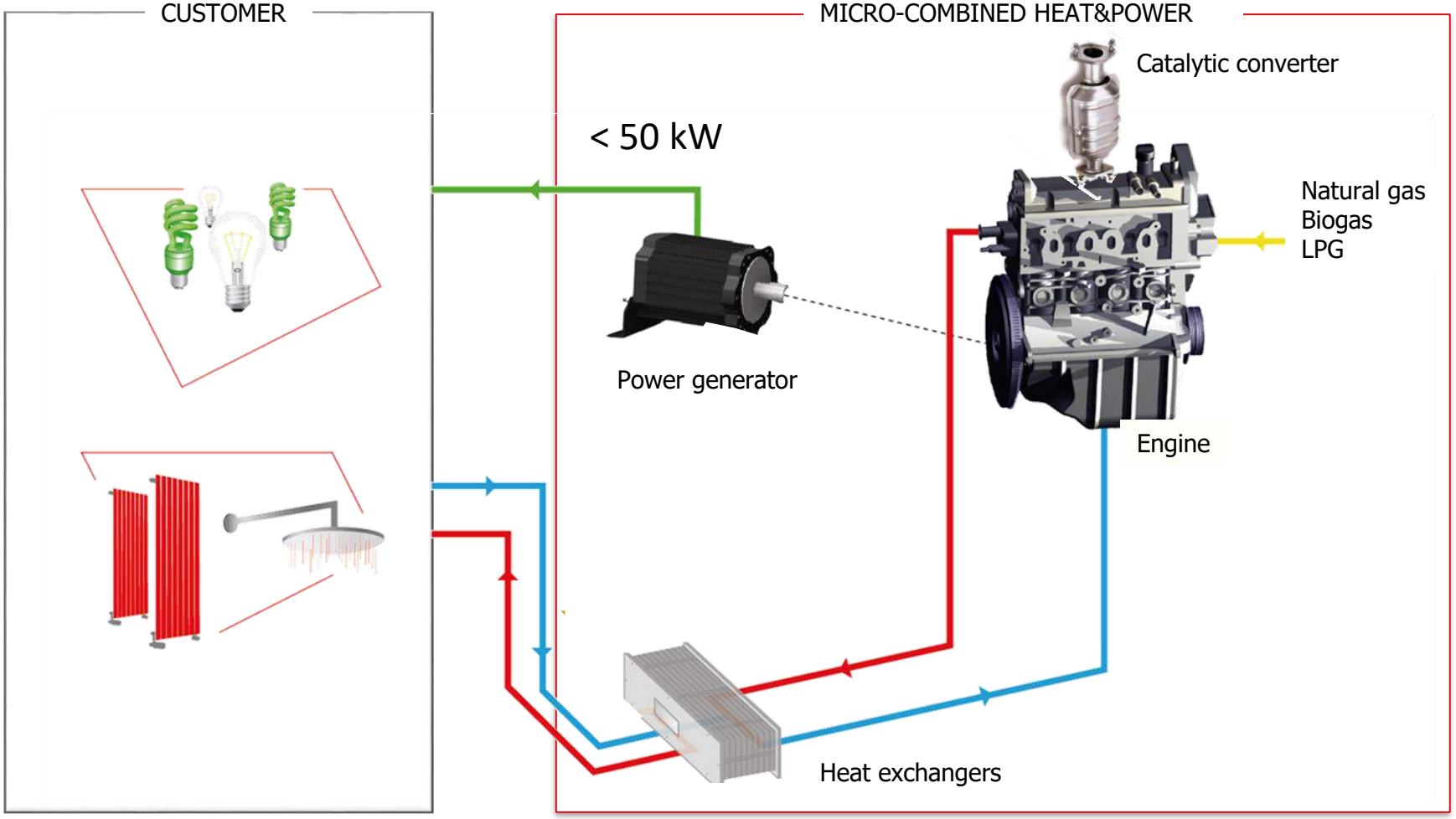
# $\mu$CHP
## CURRENT TECHNOLOGIES



# $\mu$CHP
## IN THE WORLD

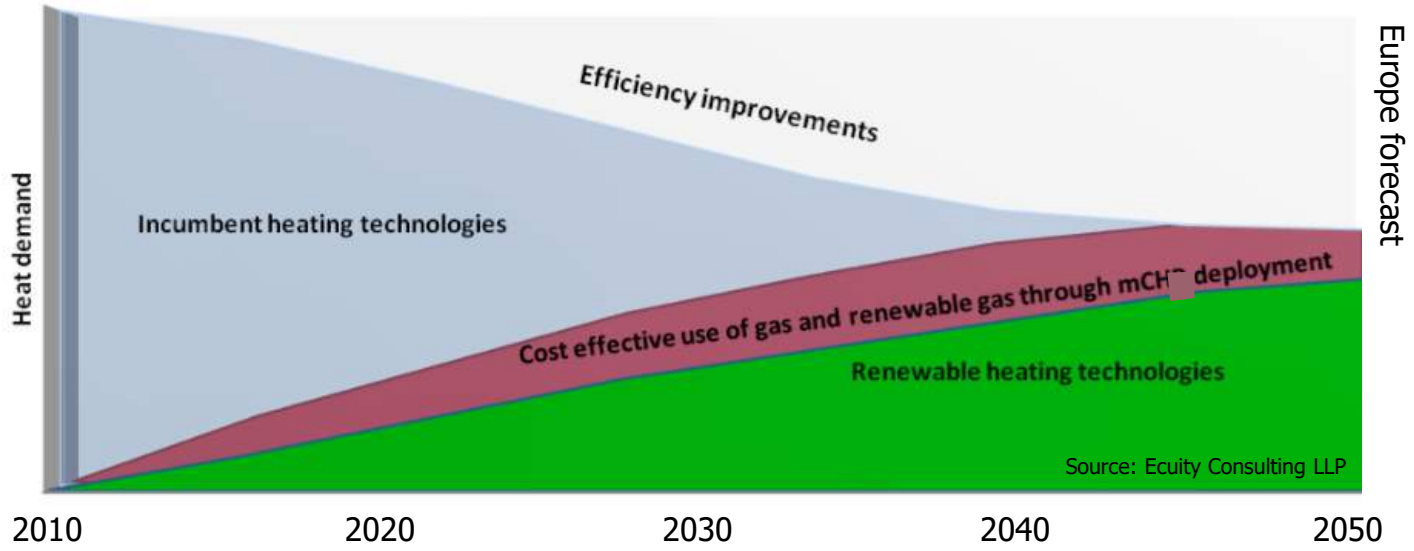


# $\mu$CHP BASED ON INTERNAL COMBUSTION ENGINES



# $\mu$CHP AND BIOMETHANE / BIOGAS

- Engine-based $\mu$CHP are flexible in terms of fuel type utilisation.
- Therefore, renewable gases like biomethane should not be overlooked as the eventual fuel of preference for $\mu$CHP.
- Renewable gas fuelled $\mu$CHP would allow the technology to become part of the portfolio of renewable solutions to attain full decarbonisation of power and heating.



# $\mu$CHP BENEFITS FOR THE USER

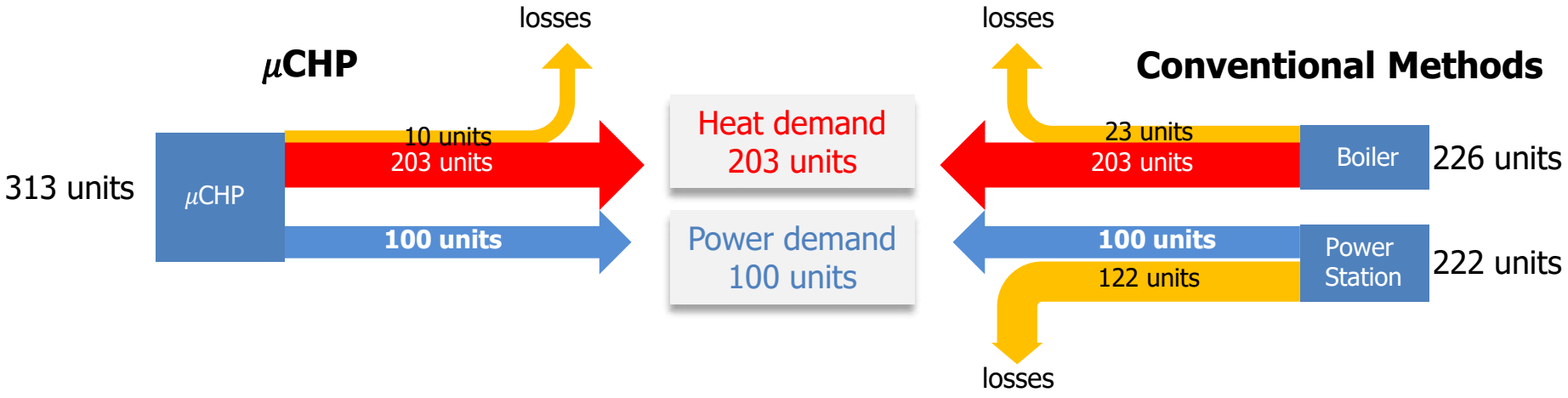

Choose TOTEM, heat is free!

TOTEM asja group

- Economic benefits
  savings on energy bills
- Enabler for District Power and Heating
- Increased security in electrical supply
  ($\mu$CHP can also work in "island" mode in the event of blackouts)
- Operation in "Peak-shaving"
  to cope with high power demand for limited time periods
- Increased "Power quality"
  to ensure constant voltage and frequency to safeguard production processes

# μCHP ENERGY SAVINGS

- μCHP brings savings as the primary energy used is less than that required for the separate production of heat and power

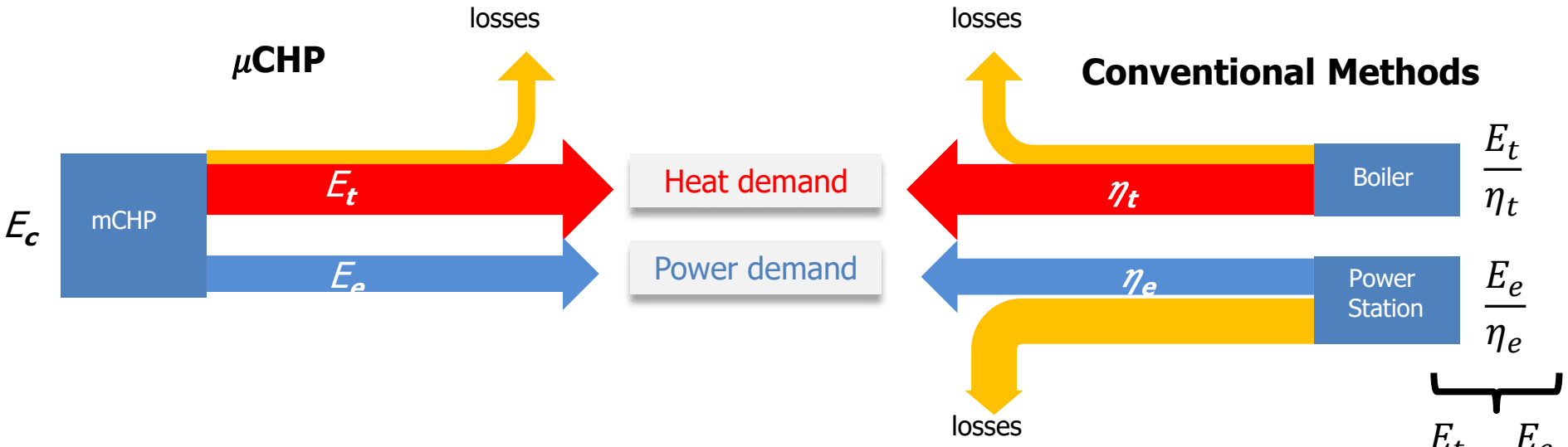



**313 units of fuel input**
**303 units of delivered energy**

**30% saving**

**448 units of fuel input**
**303 units of delivered energy**

# $\mu$CHP PRIMARY ENERGY SAVINGS

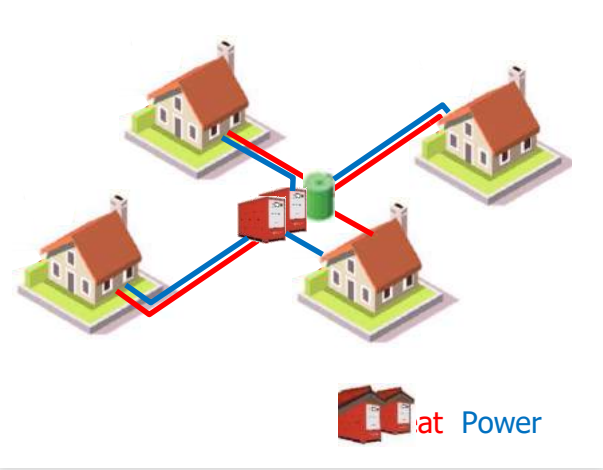



Energy Saving: $\Delta E_c = E_p - E_c$

Primary Energy Saving: $PES = \frac{\Delta E_c}{E_p} = 1 - \frac{E_c}{E_p} > 0$

# $\mu$CHP DISTRICT POWER & HEATING

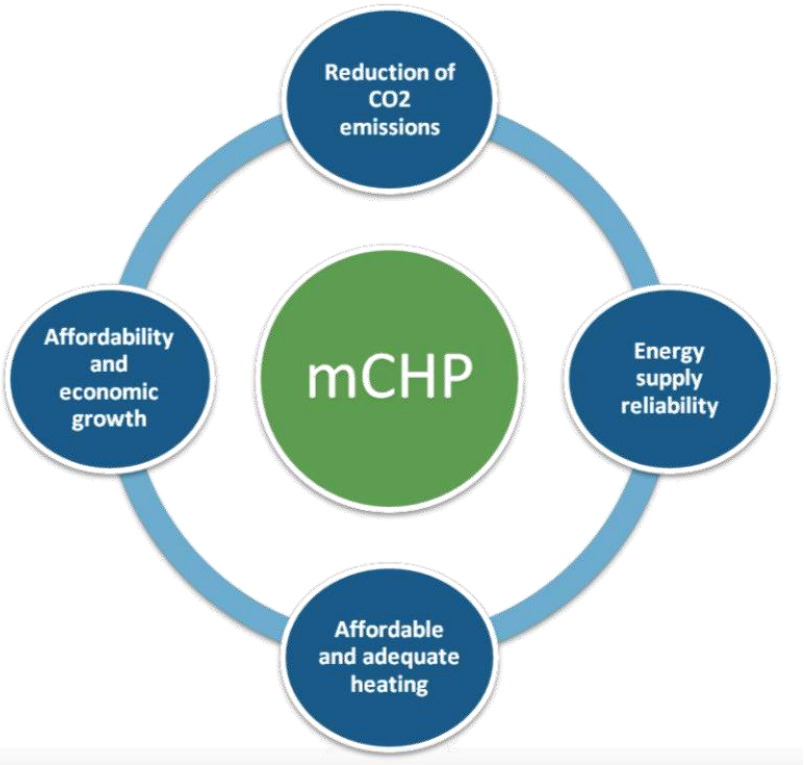
Aside from an ideal like-for-like heating replacement in individual properties, $\mu$CHP is well placed to operate in a modular fashion in a shared environment, benefiting from economies of scale. $\mu$CHP is an ideal solution for social housing or for a block of flats and community heating schemes. The modular deployment of $\mu$CHP may become the predominant commercialisation means as the decarbonisation targets become more stringent.




Distributed $\mu$CHP clusters can jointly make a low emission District Power and Heating.

In fact, $\mu$CHP can meet with flexibility the distributed customer demand of heat & power with emissions up to 20 times lower than modern boilers and 20% less $CO_2$ over centralized electricity generation.

# $\mu$CHP BENEFITS FOR THE ELECTRICAL SYSTEM AND FOR THE COUNTRY

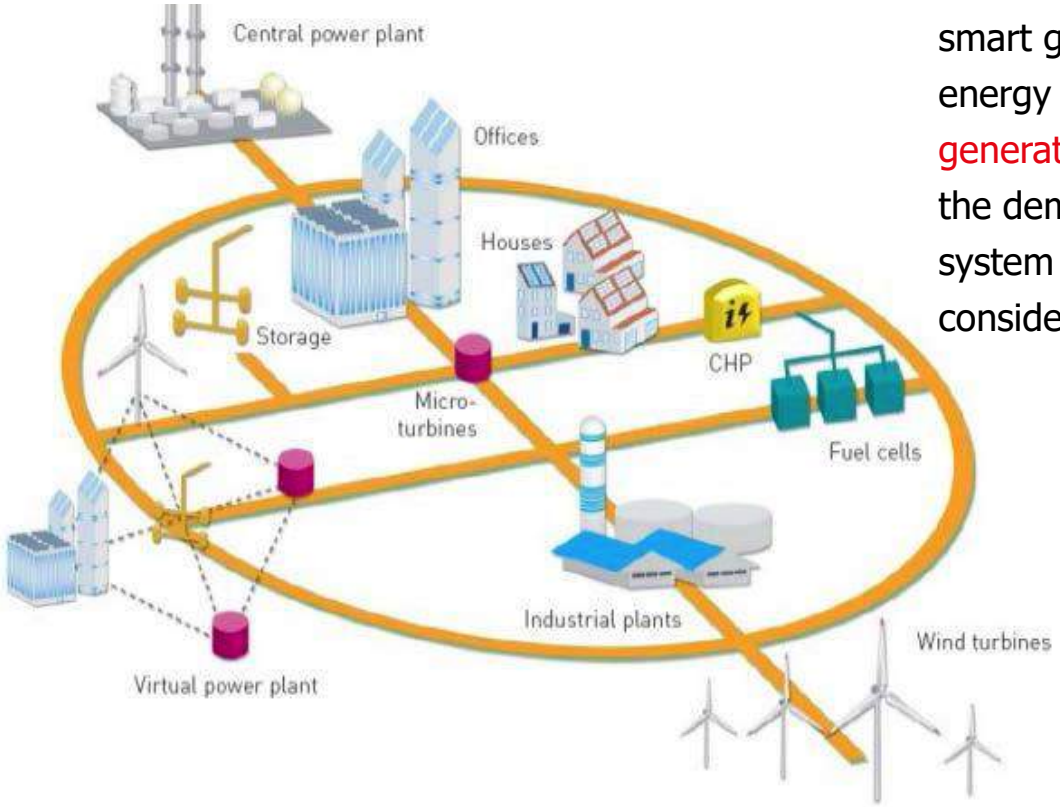



- Benefits for the balance of payments and decreased dependence on import of fossil fuels
- Reduced $CO_2$ and noxious emissions (reduced dead and health costs)
- Decreased occurrence of overload conditions in the transmission lines, with increased resilience of the electric grid
- Reduced transmission and distribution losses
- Encouragement of new energy providers liberalization of the energy sector

# $\mu$CHP BENEFITS FOR THE ELECTRICAL SYSTEM AND FOR THE COUNTRY

- Widespread $\mu$CHP uptake could complement significant investment in centralised generation, or indeed transfer a considerable proportion of electricity generation from big centralised power stations to the local level
- About 7% of all generated electricity is lost when it is transported to consumers as a result of transmission and distribution losses. $\mu$CHP penetration would allow the efficient generation of electricity by alleviating losses of electricity
- In an environment that favours a more important role for local energy generation, $\mu$CHP is the most controllable distributed energy technology. The power output of $\mu$CHP can allow enhanced viability in local power generation as a result of its flexibility and natural fit with key renewable solutions and domestic electricity demand

# $\mu$CHP SMART GRID INTEGRATION



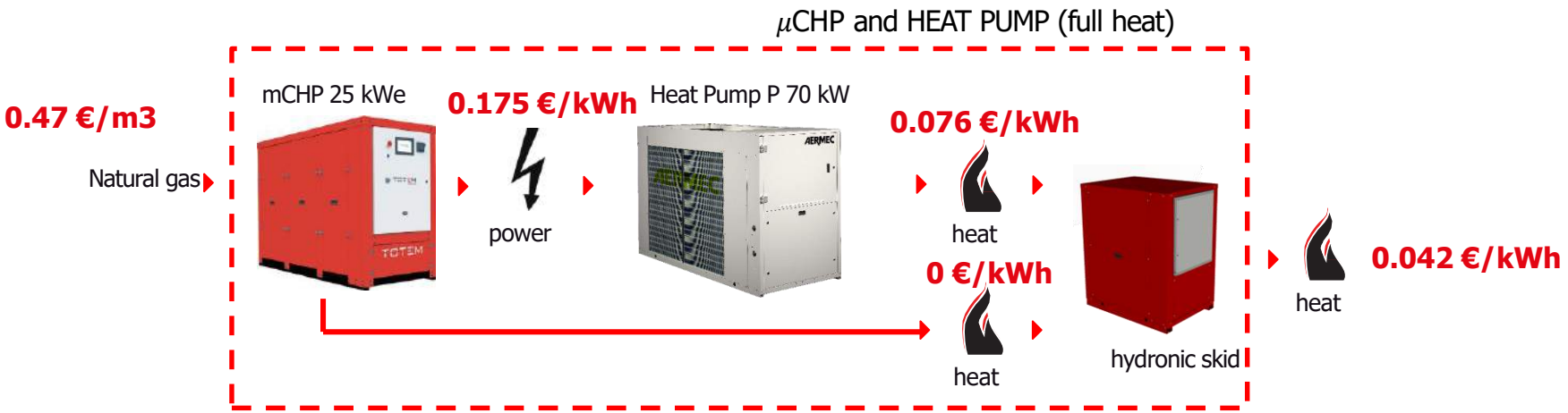

With the deployment of smart meters and the smart grid coupled with improvements in energy storage, $\mu$CHP flexibility would generate innovative possibilities to incorporate the demand side more actively in power system operation (prosumers) with considerable benefits.

# INTEGRATION OF THE $\mu$CHP WITH THE HEAT PUMP

- The change in the Building Regulations by the end of the decade that will require any replacement of heating system to achieve a carbon reduction improvement vs. condensing boilers has the potential to establish a vibrant low carbon heating market.
- Such change would generate a level playing field for low carbon heating products, including $\mu$CHP .
- The power generated by the $\mu$CHP can be used by a Heat Pump to produce additional heat or to operate as a chiller.
- The combination of $\mu$CHP + Heat Pump can serve as a simple means of readily upgrading the existing stock of residential gas boilers and can integrate with legacy high-temperature heating systems (e.g. radiators, pumps)
- The global efficiency of the $\mu$CHP + Heat Pump systems can be as high as 160%:

  100 energy units of natural gas become 160 units of heat to the end user

# μCHP AND HEAT PUMP
## FULL HEAT

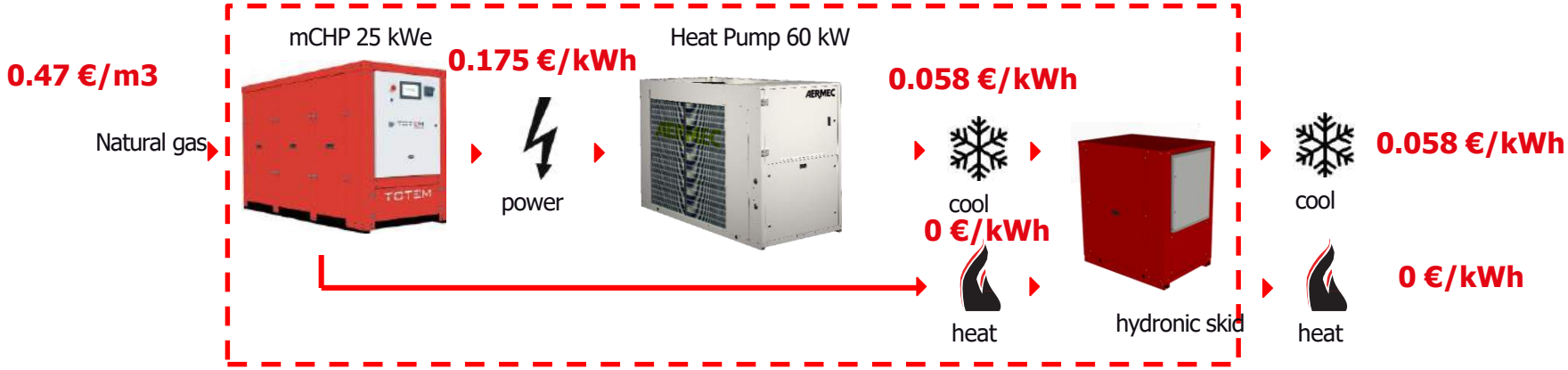



**Vs** Heat Pump alone

**-45%**

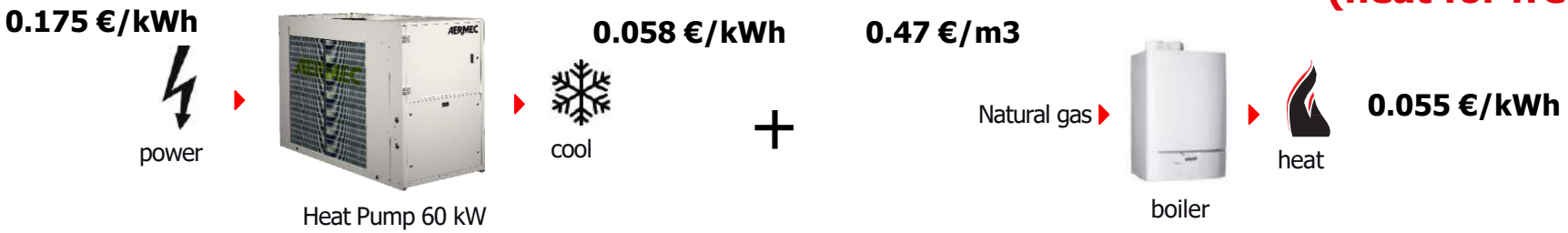
# μCHP AND HEAT PUMP
## HEAT & COOL

mCHP and HEAT PUMP (heat&cool)




**Vs** Heat Pump and Boiler

**-50%**
**(heat for free)**



# A BRIEF HISTORY

The first μCHP was patented in 1977 by FIAT with the trademark TOTEM (15 kWe)


1977

Growing demand for energy efficiency solutions

1987

1997

Asja Group acquired TOTEM brand and started the TOTEM 2.0 micro CHP development

2007

2013

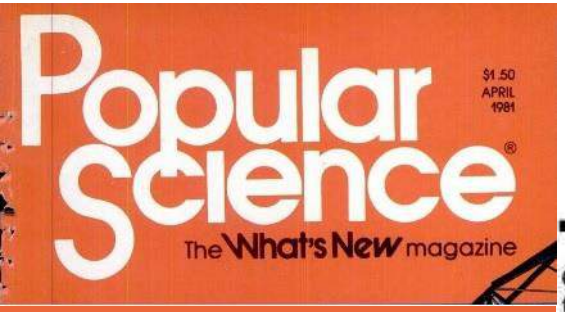
2015

2017

Launch of the New TOTEM (10- 20 - 25 kW)

40th anniversary 1977 2017

# TOTEM
## THE BEGINNING (1981)



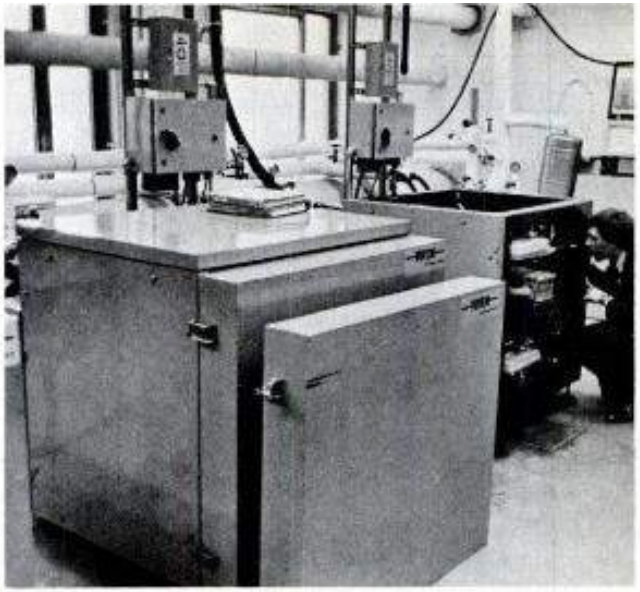

«...Now a small co-generation unit, developed and marketed by Fiat in Europe and called TOTAL Energy Module, or TOTEM, is available in the U.S. Through Brooklyn Union Gas Co. In New York City...»

## Co-generator produces heat and electricity

Co-generation—burning fuel to produce both heat and electricity—is an old conservation idea that has recently been revived and hailed as an energy-saving alternative. Now a small co-generation unit, developed and marketed by Fiat in Europe and called the Total Energy Module, or Totem [PS, Aug. '77], is available in the U.S. through Brooklyn Union Gas Co. in New York City.

The heart of Totem is a 903-cc, four-cylinder internal-combustion engine—the standard engine in the Fiat 127 automobile. But Totem's engine has been modified to burn a variety of fuels, including natural gas, biogas, and propane, as well as methanol and other alcohols. The engine drives a 15-kW induction generator, producing electricity that can be fed into a utility grid or can supply power directly to a user's own circuits. Heat is extracted from the combustion process by circulating water through four primary and secondary heat exchangers, drawing heat from the generator, engine coolant, crankcase oil, and exhaust. The recaptured heat is used for domestic hot water, space heating, or, with the help of absorption water chillers, for air conditioning.

Totem has a fixed output ratio: Two-thirds is heat, one-third is electricity. Besides a 15-kW electrical output,



**Compact Totem co-generators** are 42" high, 41" wide, 46" long. Size will differ on U.S. version to fit through average door.

Totem generates 131,000 Btu/hr. That's enough heat to supply hot water for 16 apartments or heat four medium-size apartments.

With a price tag of about $10,000, Totem is well suited to apartment buildings, restaurants, hotels, hospitals, and a variety of industrial applications. Fiat hopes to introduce the Totem concept to the U.S. by selling 100–200 units.

For more information, write to Totem Project, Bob Ritacco, Brooklyn Union Gas, 195 Montague St., Brooklyn, N.Y. 11201.—*Jeanne McDermott*

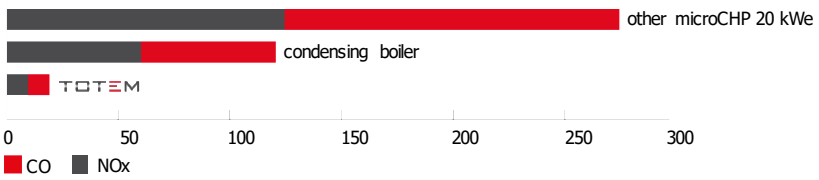
# TOTEM
## INSIDE (1/2)

# TOTEM
## INSIDE (2/2)

# TOTEM
## NOT JUST CUTTING THE BILL


The innovative technologies developed to meet the emission limits of Euro6, ensure that TOTEM emissions are 20 times lower compared to a condensing boilers (CO < 10 mg/Nm$^3$ and NOx < 10 mg/Nm$^3$). As such TOTEM is compliant with the most stringent national standards.

Emissions for different technologies



# TOTEM
## FEATURES @ 50HZ

| MODEL | | TOTEM 10 | TOTEM 20 | TOTEM 25 |
|---|---|---|---|---|
| Rated electric power | kW | 10 | 20 | 25 |
| Rated thermal power | kW | 21,6 (25,2*) | 41,9 (48,5*) | 50,2 (57,6*) |
| Electrical efficiency | % | 29,6 | 31,2 | 32,5 |
| Total efficiency | % | 93,6 (104,3*) | 96,5 (106,8*) | 97,8 (107,4*) |
| Engine | | Fiat Fire 1400 cc | | |
| Engine Control Unit | | Magneti Marelli | | |
| Fuel | | methane, biomethane, LPG | | |
| Fuel consumption ($CH_4$) | $Nm^3/h$ | 3,31 | 6,28 | 7,54 |
| Emissions (NOx)@ 5%$O_2$ | $mg/Nm^3$ | ≤ 10 | | |
| Emissions (CO) @ 5% $O_2$ | $mg/Nm^3$ | ≤ 10 | | |

### Fiat Chrysler Automobiles engines and
Magneti Marelli technologies

### Multi fuel
methane, biomethane and LPG

### Reliable
with high level of efficiency over time

### Short payback
2 - 4 years due to savings on energy bills (heat and power)

### Indoor / outdoor
installation inside and outside

### Operation
single and cascade operation; 50 or 60 Hz

# TOTEM
## FEATURES @ 60HZ

| Model | | TOTEM 25 |
|---|---|---|
| Rated Electrical Power | kW | 25 |
| Rated Thermal Power | BTU<br>kW | 170,600 (195,200*)<br>50 (57.2*) |
| Net electrical efficiency (LHV) | % | 31.2% |
| Total efficiency (LHV) | % | 94.2 % (103.3%*) |
| Inlet water temperature | °F / °C | 158 / 70 |
| Engine | | FCA Fire 1400 cc |
| Engine Control Unit | | Magneti Marelli |
| Fuel | | Natural Gas |
| Black-out start capability | | Yes |
| Input power rate (LHV) | BTU (kW)<br>Th/hr | 270,760 (79.3)<br>2.71 |
| Input power rate (HHV) | BTU (kW)<br>Th/hr | 300,214 (87.9)<br>3.00 |
| Gas pressure requirement | W.C. | 8 |
| Emission settings (NOx)@ 5% $O_2$ | lb/MWhr | < 0.10 |
| Emission settings (CO)@ 5% $O_2$ | lb/MWhr | < 0.10 |

* Referred to the input water temperature 95 F (35 °C)

- **Modulation**

  From 7.5 - 25 kW of electricity and 15 - 57 kW of heat. Electricity generated matches customer's demand without exceeding the required need

- **Black-out start**

  Working while grid failure or power outage. In black-out start mode TOTEM can be fueled either with natural gas or propane

- **Single phase ready**

  Through the 3+1 wires inverter it can supply three single phase sub grid at once

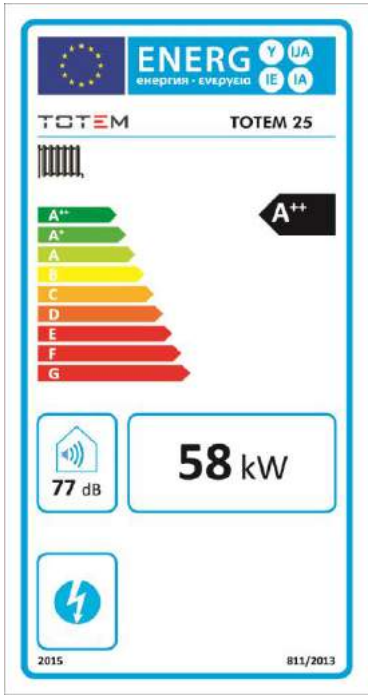
- **Emissions**

  TOTEM emissions are up to 20 times less than a condensing boiler

# TOTEM
## CERTIFICATIONS

Type Approved
Safety
Regular Production
Surveillance
TÜVRheinland
CERTIFIED
www.tuv.com
ID 1111210266

POLITECNICO
MILANO 1863




The TOTEM is the first $\mu$CHP that is awarded with the mark of an accredited institution.

Technical performances, measured by Micro-Cogeneration laboratory of Politecnico di Milano, are verified by TÜV Rheinland Italy that also certified TOTEM's compliance with the most stringent technical safety regulations.

UL certification will be granted within August 2017.

# TOTEM
## PRODUCTION

Production plant is located in Turin (Italy). It is over 2,100 m² area designed according to the maximum efficiency standards: all taking place within that area, from research and development of new models to the production, assembly and testing, is characterized by a rational use of energy produced and consumed.

Production capacity is currently set up to 600 units per year.


# Micro-Combined Heat & Power Generation

part 02 | TOTEM @ WorldWide

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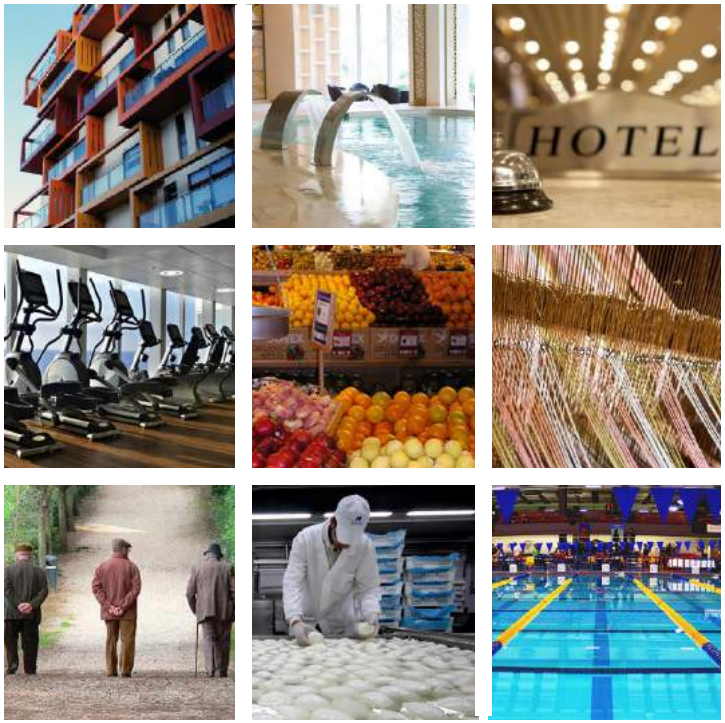
TOTEM asja group

WORLD GREEN BUILDING COUNCIL

A SUSTAINABLE TRAINING INSTITUTION

ITC International Training Centre Centre international de formation Centro Internacional de Formación

# APPLICATION




- Wellness centers
- Accommodations
- Restaurants
- Healthcare
- Residential
- Public
- Agricultural sector
- Distribution
- Small/medium industry

# BUSINESS CASE
## CONDOMINIUM | PAYBACK CALCULATION

| | |
|---|---|
| **Annual energy cost without TOTEM** | |
| Heat (38,383 therm/year ) | 137,015 € |
| Power (496,904 kWh/year) | 112,052 € |
| **Solution** | |
| TOTEM 20 | × 2 |
| Working hours | 4,917 |
| **Annual energy and operation cost with TOTEM** | |
| Heat | 86,086 € |
| Power + TOTEM Operations cost | 131,166 € |
| **Cumulative net savings for 10 years** | **209,250 €** |
| **Payback Time*** | **3.4 years** |

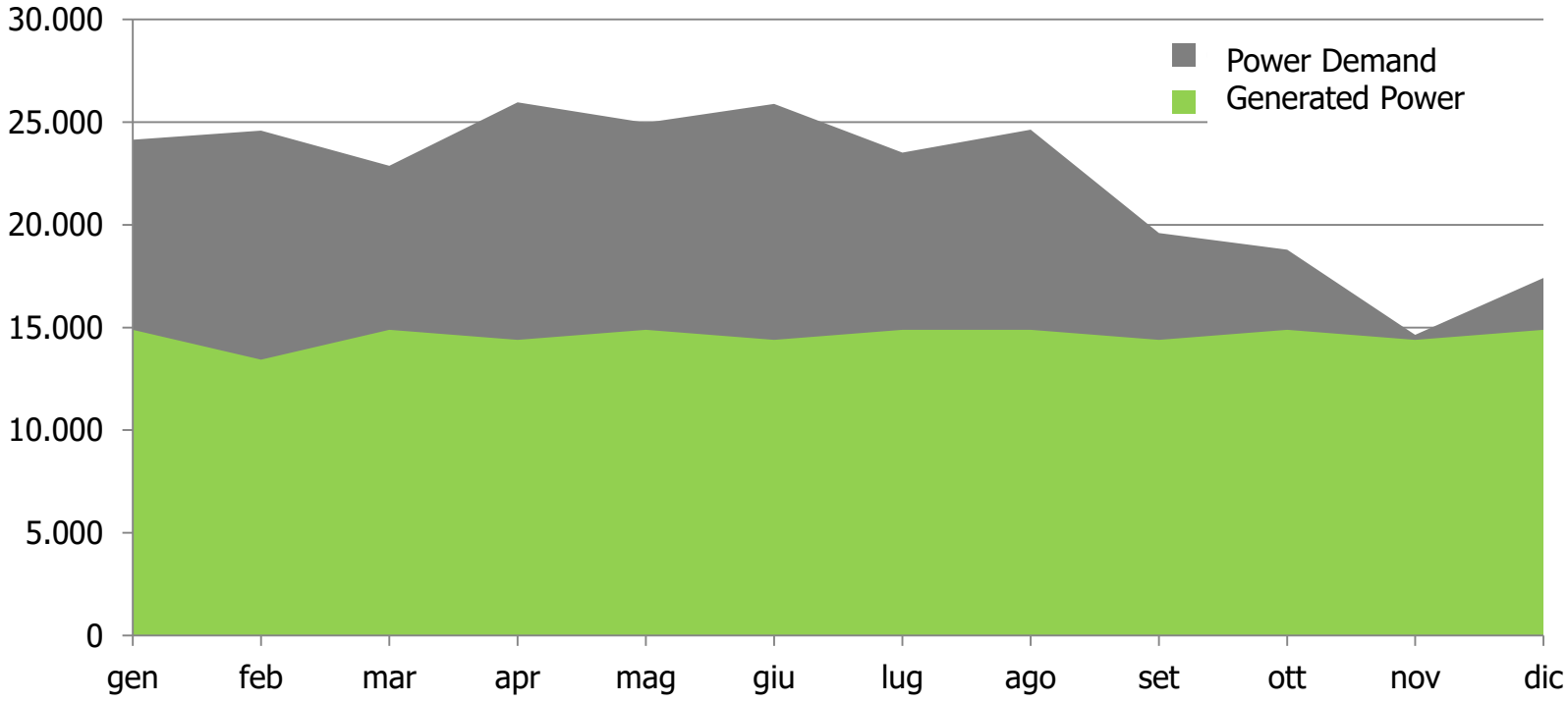
* With reference to energy prices applicable to Italy. TOTEM unots w/o black start feature.

# BUSINESS CASE
## SWIMMING POOL | PAYBACK CALCULATION

| | |
|---|---|
| **Annual energy cost without TOTEM** | |
| Heat (39,247 therm/year ) | 78,621 € |
| Power (267,045 kWh/year) | 49,817 € |
| **Solution** | |
| TOTEM 20 | x 1 |
| Working hours | 8,760 |
| **Annual energy and operation cost with TOTEM** | |
| Heat | 54,937 € |
| Power + TOTEM Operations cost | 53,465 € |
| **Cumulative net savings for 10 years** | **144,870 €** |
| **Payback Time*** | **2.7 years** |

* With reference to energy prices applicable to Italy. TOTEM unots w/o black start feature.

# SWIMMING POOL
## POWER DEMAND COVERAGE



# HOTEL
## REFERENCE CASE

## Hotel Du Cheval Blanc

**Unit type**
TOTEM 20

**Number of units**
2

**Fuel type**
Natural Gas

**Application type**
Tourist accommodation

**Location**
Northern West | Italy

# HOTEL & SPA
## REFERENCE CASE


**Hotel Weiss**

Unit type
TOTEM 20

Number of units
1

Fuel type
Natural Gas

Application type
Tourist accommodation

Location
Angermünde | Germany

# RETIREMENT HOUSE
## REFERENCE CASE

## Retirement House Sant'Anna

**Unit type**
TOTEM 20

**Number of units**
1

**Fuel type**
Natural Gas

**Application type**
Healthcare

**Location**
Eisenach | Germany

# STUDENT ACCOMODATION
## REFERENCE CASE


**Unit type**
TOTEM 10

**Number of units**
1

**Fuel type**
Natural Gas

**Application type**
Residential

**Location**
Luton, London | United Kingdom

# PUBLIC
## REFERENCE CASE

## Fire station

**Unit type**
TOTEM 20

**Number of units**
1

**Fuel type**
Natural Gas

**Application type**
Public

**Location**
London | United Kingdom

# TOTEM
## GERMANY

### Drivers

- CHP supportive policy development last 15 years
- From 2012 - 2015 in the range from 10 - 50 kWel 6.937 units were installed (192 MW el)
- BAFA incentives (major CHP incentive in the country; incentive amounts up to €4.375/unit)
- KWKG incentives (€ 0,04/kWh for self consumption in addition to TOTEM generation savings or € 0,08/kWh for selling electricity back to the grid)
- CHP awareness and acceptance by end users are the highest in GE among other EU countries

### Opportunities

- In 2016 the last amendment has been launched to CHP law to make conditions more favorable to self consumption
- Need to replace mCHP units installed 10 - 15 years ago

# TOTEM
## UNITED KINGDOM

### Drivers

- Increasing power prices
- Reduced Ghg emissions
- Building regulations 2010 (legal binding requirements);  micro CHP is one of the technologies that is allowed by LZC (Low and Zero Carbon Energy Source) to meet building regulations

### Opportunities

- Up to 10 million new homes will be needed by 2050
- Existing stock needs boiler replacement; micro CHP is ease of retrofitting

# TOTEM
## USA 60 Hz


### Drivers

- Cut-Down in electricity expenses
- Reduced GHG emissions (Obama plan)
- Absolute product for boiler replacement (boiler replacement program to meet the emission limit)
- State supportive Government polices (payback is 1 - 2 years)
- Natural gas discounted rate (in some states) for cogeneration
- Promoting and supporting mCHP by gas utilities

### Opportunities

- Boiler replacement market
- Residential/commercial applications

Shown are the **best locations for Micro CHP** based on payback, policies, net metering rules, discounted natural gas prices, length of heating season, emissions regulations and an experienced dealer network.

# TOTEM
## CANADA 60 Hz


Shown are the **best locations for Micro CHP** based on payback, policies, net metering rules, discounted natural gas prices, length of heating season, emissions regulations and an experienced dealer network.

## Drivers

- Rising energy cost
- Long heating season (up to 10 months)
- Advanced CHP technology is more accessible for properties
- 7% of electricity is produced using cogeneration
- Supportive Government policies (cover up to 80% of investment cost)
- Recurrent grid outages
- Need to reduce grid demand and improve infrastructure cost and time effective

## Opportunities

- Real estate investment companies
- Residential/commercial applications


## Drivers

- Growing economy, LNG and LPG network and reserves
- Existing projects of RES and energy efficiency
- Support country's economic growth (power and heat supply for textile, food, chemical and commercial plants)
- Urgent need for energy supply Limited access to electricity
- Avoiding distribution losses which represents 10-12%
- Creating reliable electricity supply

## Opportunities

- Residential buildings, hospitals and schools
- Small commercial industries
- Most attractive states: Morocco, Jordan, Egypt and South Africa

# TOTEM
## BALKANS

### Drivers

- Efficient urban planning - migration to urban areas are increasing, need to improve energy efficiency and security in new building and retrofits.
- Decrease energy import - promoting energy efficiency gives possibility to meet energy needs without expensive import.
- Reducing - GHG gases and other environmental and social impact.
- More and more adopting incentives to support RES and energy efficiency (ex. Bosnia and Herzegovina, the guaranteed prices for the purchase of electrical energy from facilities using RES and CHP).

### Opportunities

- Excising opportunities for large CHP and biofuel
- Micro CHP without incentives bring to 7-8 years payback
- Additional study needed and possible pilot projects

# RES4MED


Asja is a member of RES4MED, a non-profit Association established in 2012 for the development of renewables in the Mediterranean Area, with a particular focus on the Countries of Maghreb.

Mr. Re Rebaudengo is Vice President of RES4MED.

RES4MED
RENEWABLE ENERGY SOLUTIONS FOR THE MEDITERRANEAN


# TOTEM Energy production plant visit


# Thank you for your attention

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